Suicide among Discharged Psychiatric Inpatients in the Department of Veterans Affairs

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ABSTRACT   Objective: The objective of this study was to explore correlates of the use of firearms to commit suicide. Methods: A national sample of psychiatric patients discharged from Department of Veterans Affairs medical centers was followed from the time of discharge until December 1999. The study explores state-level measures as correlates of overall suicide and suicide by firearm, controlling for individual sociodemographic characteristics and psychiatric diagnosis. The outcomes of interest were completed suicide and suicide by firearm. Results: Patients who were male, Caucasian, and who had a diagnosis of substance abuse or post-traumatic stress disorder were significantly more likely to use a firearm than another means to commit suicide. Multivariable models indicated that veterans living in states with lower rates of gun ownership, more restrictive gun laws, and higher social capital were less likely to commit suicide with a firearm. Conclusions: Gun ownership rates, legislation, and levels of community cohesiveness are significantly associated with the likelihood of psychiatric patients committing suicide with a gun.

INTRODUCTION

Suicide is a growing public health problem that has received the attention of the Surgeon General,[1] among other community advocates. Guns in particular play an important role in the suicide rate in the United States; they constitute the most commonly used method for suicide death in this country.[1] In 1998, 57% of all suicides were committed with a firearm, more than three times more than the next most common method, hanging.[1]

Research on the patterns of firearm suicide has found both sociodemographic and regional variation in suicide by firearms. Rates are higher among men,[1] particularly older men,[2,3] and are highest among the elderly,[1,4] although the largest number of gun suicides are committed among younger adults.[1,5] Rates are higher among widowed men and married women as well as those with fewer years of education.[1] Caucasian race and living in a metropolitan area are associated with a lower likelihood of firearm suicide,[3] although the rates among younger African American males are rising rapidly.[6]

With respect to regional variation, rates are highest in the east and west south central areas of the country,[3,4] even after adjusting for gender and race.[7] Epidemiological research has found a robust correlational relationship between state levels of household firearm ownership and state-level suicide rates.[8,9] Access to firearms and gun ownership rates have been consistently shown to be associated at the population level with rates of firearm suicide,[7,9–12] and regional variation in such deaths is thought to be at least partially explained by these variables.[7,13]

The research on the correlation between gun ownership and firearm suicide has prompted several studies of the effects of gun legislation. In general, results have indicated that firearm suicides decrease after the enactment of gun legislation such as the Brady Bill in the United States[14,15] and Bill C-51 in Canada.[16,18] However, it is less clear whether such legislation reduces overall suicide as well as firearm suicide. Although some data suggest that reduced access to guns may lead to a substitution of nonfirearm means of suicide,[16,18–22] other data are not consistent with a substitution hypothesis.[15–17,23–25]

Previous studies in this area have two limitations. First, correlations of state-level (or otherwise geographically clustered) data suffer from the ecologic fallacy: although suggestive, correlational studies at the state level cannot be used to characterize determinants of individual behavior, since it is unclear that both the population access to firearms and the background risk of suicide would be equally mirrored in any given individual. However, data at the individual level, which strengthens the ability to make causal inferences, are difficult and expensive to collect, due to the relative rarity of suicide as an outcome in the population. Thus, most suicide studies that are able to incorporate individual data suffer from small sample sizes and limited generalizability.

The second limitation is the inability to examine these relationships among a particularly vulnerable population, those with psychiatric disorders. Although at highest risk for suicide, and more likely to use a gun to attempt suicide,[26] those with mental illness often cannot be identified individually in ecologic data, and so psychiatric diagnosis cannot be adjusted for in multivariable models.

This study uses a different approach to the study of ecologic variables and suicide risk. The data used in this study contain individual sociodemographic and diagnostic data on a large sample of >100,000 psychiatric patients, on whom we have mortality data. We are thus able to examine the effect of ecologic variables such as state suicide rates and gun legis-

lation, while adjusting for several individual characteristics that could confound such an association. We specifically address the following questions: (1) what are the sociodemographic and clinical correlates of firearm suicide among discharged psychiatric inpatients and (2) after adjusting for those correlates, is there a significant association between the individual risk for firearm suicide and a variety of state-level characteristics, including the state level of gun ownership and the restrictiveness of state gun legislation?

METHODS

Sample

The sample included all patients discharged with a diagnosis of major affective disorder, bipolar affective disorder, post-traumatic stress disorder (PTSD), or schizophrenia from psychiatric inpatient units in the Department of Veterans Affairs (VA) health care system over a 4-year period, from January 1, 1994 to December 31, 1998. The VA system is the largest integrated health care system in the world, serving poor and disabled American military veterans for a complete array of medical and psychiatric illnesses. The four disorders listed above were chosen for their severity and prevalence within the VA inpatient system. Together, schizophrenia, other psychoses, and PTSD alone account for ~60% of VA inpatients.[27] Acute care inpatient psychiatric units were defined by VA bed section codes 70–71, 75–79, 89, and 91–93.

Observations were unduplicated by including only the first discharge in the time period for each patient. It should be noted that although labeled "the index inpatient stay," it was not necessarily the first hospitalization in a patient's lifetime. The Patient Treatment File, a VA administrative database of all episodes of inpatient care delivered within the VA system, was used to identify the sample and unduplicate the data. The sample consisted of 119,159 individuals on whom we had complete individual and state-level data. Because this was a secondary data analysis, informed consent was not obtained, however, the project was reviewed and approved by a human investigations committee.

A second analysis used a subsample of the data consisting of those patients who committed suicide between the time of their discharge and December 31, 1999 (*n* = 1,057).

Identification of Deaths

Once the sample was identified, data were merged with the National Death Index (NDI) to determine whether a patient was deceased. The NDI is a virtually complete database on every death occurring in the United States, including death certificate information. NDI matches were accomplished using social security number as the primary identifier. Previous work with NDI and VA data indicated that social security number was the most valid matching criteria, leading to low false-positive rates.[28]

Cause of death was coded as suicide if it fell into the range of International Classification of Diseases (ICD)-9 codes 950–959 (deaths before 1999), or ICD-10 codes X60–X84 (deaths in 1999), and was further classified into those by firearm (955.0–955.4) and those by other means. To determine cause of death, we used a recoded cause of death variable provided by the NDI based on a nosological algorithm that determined, among all listed causes of death, which should be considered the "primary" cause of death.[29] Of the total sample, 1,057 patients (0.89%) committed suicide, of whom 440 (41.6%) used a firearm.

Individual Characteristics

Administrative data available from the Patient Treatment File were used to identify sociodemographic and clinical characteristics of the sample, including age, race, marital status, service-connected disability status (none, <50%, >50%), year of inpatient discharge, and psychiatric diagnoses. Diagnoses, which were nonexclusive to allow for comorbidity, included PTSD, major depression, bipolar disorder, and schizophrenia (all subjects had at least one of the above), as well as drug abuse/dependence, alcohol abuse/dependence, and other diagnoses (comprised primarily of other anxiety disorders and personality disorders).

State-Level Characteristics

We used eight state-level variables to examine whether environmental factors affected the likelihood of gun-related suicide, above and beyond individual sociodemographic and clinical factors. These nine variables were the percent of the population living in a census-defined standard metropolitan area (a measure of urbanization), the percentage of the population that identified themselves as a racial minority, the per capita income in thousand dollars, the percentage of the population living below the poverty line, the overall state suicide rate, a measure of social capital, a measure of the restrictiveness of the state gun legislation, and rates of household gun ownership.

The data for the first four of these factors (urbanization, racial diversity, per capita income, and poverty rates) were obtained from the U.S. Census Bureau.[30] State-level suicide rates were obtained from the American Association of Suicidology,[31] which bases their reports on the National Center for Health Statistics mortality data. The rate applied to each patient was the rate in their home state during the year they were discharged from psychiatric inpatient care.

Measures of state-wide social capital, a measure of social cohesion and trust in the community, were provided by Putnam,[32] whose index of social capital is represented by summarizing measures in five domains: the level of community organizational life, engagement in public affairs, community volunteerism, informal sociability, and social trust. These domains were combined into a single social capital index for each state. Data for these measures were largely obtained from large social surveys such as the General Social Survey.[33]

The gun legislation variable was a measure of the restrictiveness of a state's gun laws and was compiled by the Open

Society Institute's Center on Crime.[34] To create the score, each state's gun laws were rated on 30 criteria and grouped into six different categories ranging from registration of firearms to required safety training. The maximum score states could receive was 100 (signifying a state with extremely restrictive gun laws) and the minimum score they could receive was −10 (signifying a state with the most permissive gun laws).

Gun ownership rates were estimated for each state using data from the 2001 Behavioral Risk Factor Surveillance System Survey Data (BRFSS).[35] The BRFSS is a national probability sample of all households with a telephone. Respondents to the BRFSS were asked, "Are any firearms now kept in or around your home? Include those kept in a garage, outdoor storage area, car, truck, or other motor vehicle."[36] The Centers for Disease Control then created state-wide estimates of gun ownership rates. Data from the 2001 BRFSS were used because they are the only known reliable estimates of gun ownership that have data available from all 50 states. Although these data postdate the follow-up period of this analysis (1999), previous research on reliable proxies for gun ownership rates has indicated that gun ownership rates are relatively stable over short periods of time.[8,13]

Data Analysis

Data analysis proceeded in several steps. First, we fit bivariate Poisson models to determine what individual characteristics (e.g., sociodemographics, diagnosis) were statistically significant predictors of firearm suicide. Those individual factors were then included in all subsequent models. Poisson models were used to account for the nonuniform distribution of deaths across the follow-up period. In addition, patients were clustered within facilities using generalized estimated equation (GEE) procedures[36] to account for the reduction in intrasubject variation within states and to allow for the analysis of state-level measures.

Next, state-level measures were examined for their association with both overall suicide and firearm suicide, adjusting for individual and clinical characteristics. Third, the correlations among the state-level variables were calculated, to determine whether there was potential colinearity that would preclude including variables together in multivariable models. Finally, state-level factors that were significantly associated with firearm suicide were included in multivariable models. All multivariable models were fit using GEE Poisson models as described above. Due to colinearity, gun legislation and gun ownership rates could not be included in models together, and so were fit separately.

RESULTS

Of the total sample, 1,057 patients committed suicide (0.89%). This rate is high compared to general population rates,[32] but are comparable to other studies of suicide in samples of psychiatric patients.[37,38] Of all completed suicides, 440 (41.6%) used a firearm. These rates are slightly lower

than recently reported population rates of gun suicide,[1] however, this small difference may be explained by slightly more restricted access to guns among psychiatric patients.

Previous research had explored the correlates of any suicide in this sample,[39] and so are not repeated here. However, Table I presents the sociodemographic and clinical characteristics of those who committed suicide, stratified by gun versus other means (total sample = 1,057). It should be noted that z scores obtained from the GEE Poisson models are adjusted for all other variables in the table. These tests indicate that males were significantly more likely than females to use a gun ($p = 0.04$), as were Caucasian patients ($p = 0.02$ compared to African-American patients), and those with a diagnosis of PTSD ($p = 0.0015$). Those who were African American or Hispanic and had a diagnosis of substance abuse/dependence (not including alcohol abuse/dependence) were less likely to use a firearm to commit suicide.

Table II examines each of the eight state-level variables as they relate to three outcomes, adjusting for sociodemographic and clinical factors: overall suicide versus no suicide ($n = 119,159$), firearm suicide versus no firearm suicide ($n = 119,159$), and firearm suicide versus alternative means of suicide ($n = 1,057$). The table indicates that patients living in states with more restrictive gun laws were significantly less likely to commit suicide in general ($p = 0.02$), and were less likely to commit suicide with a gun either in general ($p = 0.0003$), or when compared to others who committed suicide ($p = 0.02$). Similar results were found for the rates of gun ownership: those patients who lived in states with higher rates of gun ownership were marginally more likely to commit suicide in general ($p = 0.05$), and were more likely to use a gun ($p < 0.0001$ and $p = 0.0005$, respectively).

Patients who lived in states with higher social capital were only marginally less likely to commit suicide in general ($p = 0.06$), but were significantly less likely to use a gun ($p = 0.01$ and $p = 0.002$, respectively). Urbanization was inversely related to the overall suicide ($p = 0.02$) and gun suicide rates ($p = 0.005$), but was only slightly associated with the use of a gun when compared to the use of alternative means ($p = 0.05$). Higher per capita income was significantly inversely associated with all three outcomes, such that patients living in states with higher incomes were less likely to commit suicide or to use a gun. Finally, the state suicide rate was associated with the individual risk of suicide ($p = 0.0002$) and the gun suicide rate ($p < 0.0001$) in this sample of psychiatric patients, but was not associated with the use of a gun to commit suicide when compared to other means ($p = 0.26$). Poverty rates and racial minority rates were not associated with any suicide outcome.

Table III presents correlation coefficients between gun legislation, gun ownership rates, and other state-level sociodemographic variables. The correlations indicate that states with more restrictive gun laws had more urban population,

TABLE I. Sociodemographic and Clinical Characteristics of a National Sample of Psychiatric Patients who Committed Suicide from 1994 to 1998 (N = 1,057)[a]

Individual-Level Variable	Non-Gun-Related Suicide (n = 617)	Gun-Related Suicide (n = 440)	z Score	p
Gender				
Male	586 (57.56)[b]	432 (42.44)		
Female	31 (79.49)	8 (20.51)	2.06	0.0392
Age (years)				
18–29	33 (58.93)	23 (41.07)		
30–39	124 (68.89)	56 (31.11)	−0.91	0.3649
40–49	277 (58.94)	193 (41.06)	−0.70	0.4819
50–59	96 (53.65)	83 (46.37)	0.17	0.8653
60–69	44 (48.35)	47 (51.65)	0.70	0.4846
70+	43 (53.09)	38 (46.91)	0.32	0.7460
Race				
Caucasian plus other	518 (56.00)	407 (44.00)		
African American	68 (72.34)	26 (27.66)	−2.27	0.0234
Hispanic	32 (82.05)	7 (17.95)	−1.95	0.0512
Marital status				
Never married	177 (63.90)	100 (36.10)		
Married	167 (53.70)	144 (46.30)	0.97	0.3327
Divorced/separated	273 (58.21)	196 (41.79)	0.96	0.3381
Disability				
Not service connected	356 (59.53)	242 (40.47)		
Service connected <50%	108 (58.70)	76 (41.30)	−0.51	0.6132
Service connected >50%	153 (55.64)	122 (44.36)	0.35	0.7243
Alcoholism				
No	459 (57.52)	339 (42.48)		
Yes	158 (61.00)	101 (31.00)	−0.61	0.5419
Substance abuse				
No	545 (57.19)	408 (42.81)		
Yes	72 (69.23)	32 (30.77)	−2.06	0.0396
Schizophrenia				
No	407 (55.53)	326 (44.47)		
Yes	210 (64.81)	114 (35.19)	0.11	0.9160
Bipolar depression				
No	481 (57.54)	355 (42.46)		
Yes	136 (61.54)	85 (38.46)	0.03	0.9791
Major depression				
No	409 (59.88)	274 (40.12)		
Yes	208 (55.61)	166 (44.39)	0.66	0.5109
PTSD				
No	500 (62.19)	304 (37.81)		
Yes	117 (46.25)	136 (53.75)	3.17	0.0015
Dual diagnosis				
No	421 (56.74)	321 (43.26)		
Yes	196 (62.22)	119 (37.78)	0.24	0.8135
Year of discharge				
1994	286 (62.04)	175 (37.96)		
1995	132 (56.65)	101 (43.35)	1.76	0.0789
1996	81 (50.94)	78 (49.06)	1.87	0.0620
1997	73 (58.40)	52 (41.60)	0.57	0.5695
1998	45 (56.96)	34 (43.04)	0.76	0.4457

[a] Results of one multivariable model in which all covariables are controlled for other covariables in the model. Analyses conducted only on those patients who successfully committed suicide following discharge from 1994 to 1998.
[b] Numbers in parentheses, percent.

larger population sizes, more racial minorities, higher per capita income, lower overall suicide rates, and lower rates of gun ownership.

Table IV presents multivariable models that included significant individual and state-level factors from Tables I and II. Per capita income and urbanization were consistently nonsignificant when entered into multivariable models, and so were dropped from the analyses.

As before, we examined three outcomes: overall suicide, gun suicide in the entire sample, and gun suicides compared

TABLE II. State-Level Correlates of Suicide in a National Sample of Psychiatric Patients 1994 to 1998

State-Level Variable[a]	Suicide vs. Nonsuicide ($N = 119,159$)		Gun Suicide vs. Nonsuicide ($N = 119,159$)		Gun Suicide vs. Non-Gun Suicide ($N = 1,057$)	
	IRR[b]	p	IRR	p	IRR	p
Gun control index	0.99	0.0213	0.99	0.0003	0.99	0.0191
Firearm ownership	1.01	0.0501	1.02	<0.0001	1.02	0.0005
Social capital	0.85	0.0579	0.79	0.0131	0.71	0.0019
Poverty rate	0.99	0.3049	1.02	0.1665	1.03	0.1757
Urbanization	0.99	0.0203	0.99	0.0047	0.99	0.0470
Percentage of the population minority	0.99	0.2063	1.00	0.8978	1.01	0.4464
Personal income per capita	0.63	0.0058	0.42	<0.0001	0.41	0.0001
Suicide rate	1.06	0.0002	1.07	<0.0001	1.03	0.2608

Models adjusted for age, race, gender, marital status, service-connected disability level, alcohol and drug use, psychiatric diagnosis, dual diagnosis, and year of discharge.

[a] All values for covariables represent 1997 figures except for firearm ownership rates which are 2001 figures.

[b] IRR, Incident rate ratio.

TABLE III. Correlation Analyses of State-Level Correlates of Suicide with a Firearm in a National Sample of Psychiatric Patients from 1994 to 1998

State-Level Variable	Correlation with Gun Control Legislation	p	Correlation with Gun Ownership	p
Social capital	0.1019	0.2599	0.0290	0.7495
Poverty rate	0.0964	0.2907	0.0062	0.9453
Urbanization	0.6064	<0.0001	−0.8275	<0.0001
Percentage of the population minority	0.4301	<0.0001	−0.3822	<0.0001
Personal income per capita	0.6627	<0.0001	−0.8017	<0.0001
Suicide rate	−0.4983	<0.0001	0.5307	<0.0001

Pearson correlation coefficients were used for 1997 data only.

to non-gun suicides. Results indicate that once models adjust for the state suicide rate, the association between gun legislation, firearm ownership, and the overall suicide rate in this sample is nonsignificant. Given that both variables were significant in Table II, this implies that the legislation and ownership rates do not have an effect on the risk of suicide in psychiatric patients above and beyond the suicide risk experienced by all citizens of the state (as measured by the state suicide rate). However, both variables continue to be significantly and strongly associated with the risk of gun suicide in this sample, even after adjusting for background suicide risk. Similarly, social capital is not significantly associated with the overall suicide rate above and beyond the background suicide rate, but is significantly associated with the risk of gun suicide compared to suicide by other means.

DISCUSSION

Overview

These analyses suggest several conclusions: first, that state-level gun ownership rates are significantly associated with the individual risk of suicide, as well as the risk of gun suicide, in this sample of psychiatric patients. Second, the restrictiveness of gun legislation, which is highly inversely correlated with the rates of gun ownership, is also associated with the individual risk of suicide and gun suicide. Third, the risk associated with state levels of gun ownership and local legislation is not particularly higher for psychiatric patients, since adjustment for state suicide levels reduces the effects of the gun variables. Finally, social capital has an independent association with the risk of gun suicide, above and beyond the effect of the environmental accessibility of guns.

It is not possible to generalize these results to the general population. However, the results could be extended to non-VA psychiatric patients with a history of inpatient care, particularly males. Analyses of the schizophrenia Patient Outcome Research Team data that compared VA to non-VA psychiatric patients found few differences in clinical severity, social functioning, psychiatric treatment, or quality of care,[40] and there is no reason to believe that these patterns would differ for other psychiatric disorders. However, this is a sample of veterans, who would presumably have more experience with and knowledge about firearms than the general population,[41] and this may affect the generalizability of results.

Possible Mechanisms

Clearly, rates of gun ownership are highly correlated with gun legislation: those states that have fewer guns also tend to

TABLE IV. Full Multivariable Models Predicting Suicide with a Firearm in a National Sample of Psychiatric Patients from 1994 to 1998

Variable	Suicide vs. Nonsuicide				Gun Suicide vs. Nonsuicide				Gun Suicide vs. Non-Gun Suicide			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	RR	*p*	RR	*p*	RR	*p*	RR	*p*	RR	*p*	RR	*p*
State-level variables												
Gun control index	1.00	0.5017			0.99	0.0084			0.99	0.0388		
Firearm ownership			1.00	0.9820			1.01	0.0223			1.02	<0.0001
Social capital	0.88	0.0725	0.87	0.0647	0.83	0.0200	0.82	0.0109	0.73	0.0021	0.71	0.0005
State-level suicide rate	1.05	0.0023	1.06	0.0003	1.04	0.0220	1.04	0.0289	0.99	0.6822	0.97	0.2586
Individual-level variables												
Gender												
Female	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Male	1.94	0.0082	1.95	0.0081	3.55	0.0004	3.54	0.0002	2.43	0.0482	2.37	0.0589
Age (years)												
18–29	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
30–39	0.68	0.1089	0.68	0.1083	0.64	0.0751	0.64	0.1261	0.73	0.3686	0.70	0.3216
40–49	0.62	0.0223	0.62	0.0224	0.67	0.0799	0.68	0.0948	0.83	0.5835	0.82	0.5622
50–59	0.73	0.1449	0.73	0.1429	0.72	0.1602	0.72	0.1924	1.09	0.8252	1.08	0.8397
60–69	0.67	0.0880	0.67	0.0864	0.62	0.0629	0.62	0.0996	1.30	0.4975	1.26	0.5568
70+	0.90	0.6164	0.89	0.6043	0.70	0.1795	0.70	0.2326	1.24	0.6236	1.26	0.5899
Race												
Caucasian plus other	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
African American	0.30	<0.0001	0.30	<0.0001	0.20	<0.0001	0.20	<0.0001	0.56	0.0104	0.55	0.0077
Hispanic	0.62	0.0646	0.61	0.0644	0.27	0.0014	0.28	0.0006	0.40	0.0517	0.41	0.0600
Alcoholism												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	0.87	0.2010	0.86	0.1930	0.89	0.3363	0.89	0.3401	0.77	0.4859	0.91	0.5381
Substance abuse												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	0.95	0.7657	0.94	0.7356	0.73	0.3104	0.82	0.3007	0.55	0.0273	0.59	0.0075
Schizophrenia												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	0.75	0.1035	0.74	0.1002	0.70	0.0441	0.70	0.0547	1.12	0.6309	1.12	0.6199
Bipolar depression												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	0.98	0.8906	0.97	0.8719	0.90	0.5339	0.89	0.5381	1.09	0.7318	1.08	0.7756
Major depression												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	1.44	0.0278	1.44	0.0299	1.38	0.0368	1.37	0.0311	1.26	0.2655	1.29	0.2329
PTSD												
No	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
Yes	0.62	0.0030	0.62	0.0029	0.89	0.4380	0.89	0.4710	2.23	0.0005	2.26	0.0005
Year of discharge												
1994	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref	1.00	Ref
1995	1.07	0.6252	1.07	0.6368	0.89	0.3375	0.88	0.2976	1.34	0.0550	1.37	0.0435
1996	0.88	0.3711	0.88	0.3645	0.83	0.1855	0.83	0.1249	1.57	0.0501	1.54	0.0672
1997	1.10	0.5417	1.10	0.5458	0.63	0.0039	0.63	0.0131	1.16	0.5029	1.16	0.5053
1998	1.24	0.1707	1.24	0.1722	0.56	0.0023	0.56	0.0044	1.20	0.4089	1.20	0.4124

RR, relative risk.

have more restrictive laws. Gun ownership is also related to social capital: those states that have heavily armed citizens also have lower levels of mutual trust and social cohesiveness.[42] The mechanisms whereby these factors may affect the individual risk of suicide are completely unknown, however, several possibilities can be suggested.

The first, and most salient, mechanism involves an individual's access to a firearm. Those who either own a firearm, or have access to one within their home, are more likely to use a gun in any action, including suicide.[8,12,13,19,43] Given that suicidal acts are often impulsive,[44] it is easy to understand how access to a weapon with great likelihood of lethality would increase the risk of gun suicide. However, the data presented here also suggest that access to a weapon increases the overall risk of suicide, meaning that an individual may not have chosen suicide had there not been a gun available. These data suggest that substitution may not be generally occurring in this sample, since the gun ownership rates were not only correlated with gun suicide, but with overall suicide as well. However, since firearms are a more lethal means of attempt-

ing suicide,[45] it is also possible that patients are substituting other means, but ones that have a lower probability of death, thus leading to an apparent negative correlation with overall suicide rates.

To further explore this issue, we examined the association between gun ownership and the rates of hanging deaths (the second most common means of suicide). The rates of hanging deaths were not significantly inversely associated with gun ownership rates, as one might expect if there were substantial substitution of hanging as a method for suicide when guns were less available ($p < 0.05$, data not shown). This further strengthens the hypothesis that restricting access to guns will save lives by preventing suicide deaths.

A second mechanism that could be proposed involves gun legislation laws. The legal restrictions on gun owners are very highly correlated with rates of ownership. However, the laws may have a differential impact upon people suffering with psychiatric disorders. For example, mandatory waiting periods for gun purchases may reduce suicide rates by allowing time for such impulses to subside. Past research has shown that the gun suicide rates are highest in the first 5 days after a gun purchase,[46] and that the increased risk persists as long as 5 years after a gun purchase.[9,46]

A third mechanism could be proposed for the effect of social capital. These results indicate that in communities that lack a supportive social environment, patients are more likely to choose suicide, and are more likely to choose a particularly violent means of suicide. It may be that psychiatric patients living in such communities have fewer social supports to help them through a crisis, have less access to mental health care by virtue of distance and geographic isolation, or respond more strongly to a general feeling of community fragmentation and hostility than would a person without a psychiatric disorder. It should be noted, however, that the state level of social capital may not be reflected in an individual patient's social capital, and these results may be heavily confounded by other factors more proximally associated with suicide risk.

Limitations

Although these analyses included both individual as well as geographically aggregated data, which may help control some confounding present in ecologic analyses, the administrative data used to control individual characteristics have some limitations. For example, the administrative data allowed adjustment only for general sociodemographic and diagnostic characteristics. Therefore, the analyses cannot account for factors such as sudden acute life events, psychiatric symptom severity, intensity of substance abuse, medication use, or a history of suicide attempts. Second, it should be noted that because we used state-level data, these analyses, although suggestive of a causal hypothesis, are still prone to ecologic fallacy. For example, we cannot conclude that a high state gun ownership rate implies that an individual patient necessarily had access to a gun. Finally, there may be unmeasured confounders at the state level that may explain or mediate the results. For example, states with higher ownership rates may also have lower rates of spending on violence/suicide prevention, state welfare, or mental health care, which may explain the association with suicide. The limitations imply that more research is needed on access to guns and its implications on the individual level, particularly among those with serious mental illness. However, the results are striking enough to warrant further attention.

CONCLUSIONS

Although these results show some striking correlations between environmental variables and gun-related suicide deaths, much remains to be known. For example, future research might assess access to, use of, and attitudes about guns in psychiatric patients, particularly those who express suicidal thoughts. In addition, clinical interventions to assess access to guns and reduce that access in suicidal patients might be tested for effectiveness at reducing suicide rates, when implemented in conjunction with other suicide prevention efforts.

The majority of gun deaths in this country are not homicides, but suicides.[35] At the level of public policy, efforts to reduce gun ownership rates, either directly through legislation or indirectly by lowering the perceived need for guns, may save many lives a year. However, more research is needed to determine whether gun control measures would directly lead to a reduction in suicide deaths.

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